CONTROL SYSTEMS
EGR 3316

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Lecture 9

Objectives:

- **After completion of this lecture, the students will be able to explain and describe:**
  - State Space Method
  - RC circuit state space model
  - RLC circuit state space model
  - State Space Model Solution Using Laplace Transform

State Space Method

- In state-space model
  - State Variables are selected
    - $x_1(t), x_2(t), ..., x_n(t)$
  - Nth order differential equation are decomposed into n first-order differential equations.
    - Called state equations
    - Solutions state equations is obtained using
      - System input
      - Initial condition
  - State equations and output equations are called state-space representation

State Space Method

Consider a CT differential equation:

The state variables:

The state equations:

State Space Method

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can write these in matrix form as:

Hence

e output in matrix form is:

Hence

State Space Method

For n^{th}-order differential equation system:

The state variables of the system are defined as

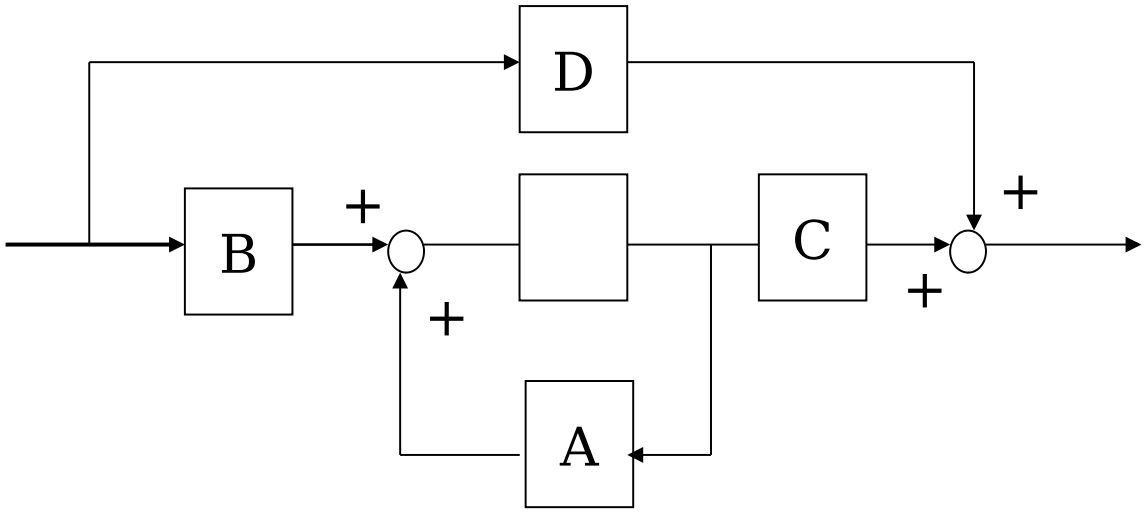
State Space Method

The resulting state equations are:

In matrix form:

State Space Method

In general, a continuous-time LTI system can be described by:



Signal Flow Graph

Q1

the state space model for the RC circuit shown in Figure 1.

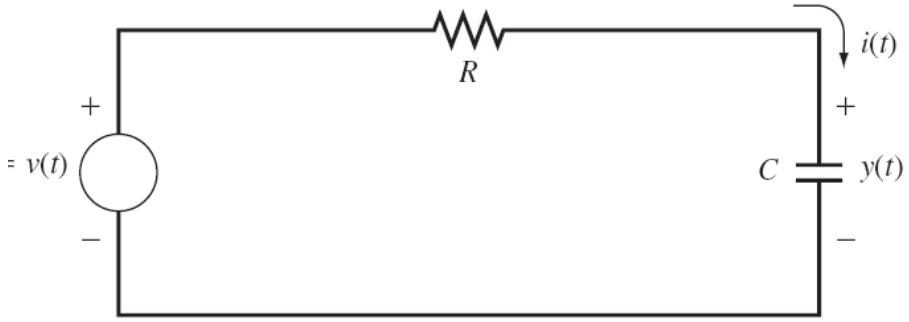
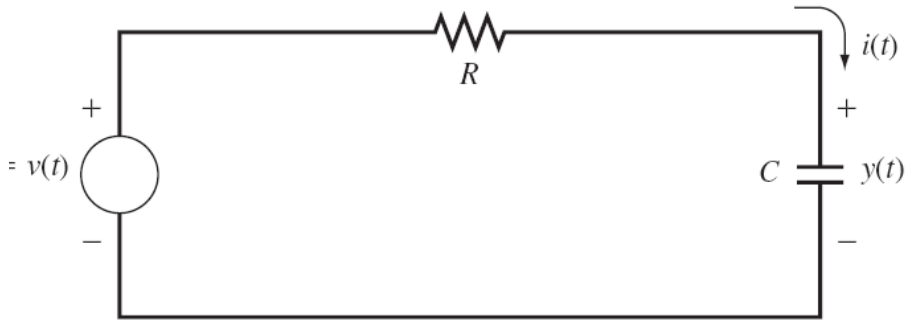


Figure 1. RC circuit

Solutions

ystem can be modeled by the following state equations:

/e can write this as:

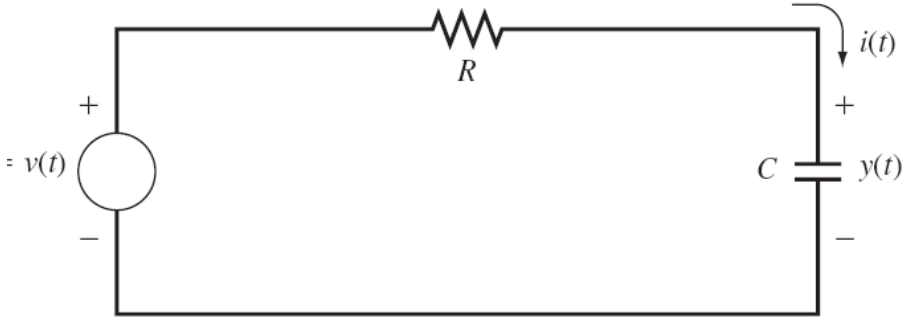


RC circuit

Let

Solutions

the following state variables, we can get the state equation



RC circuit

Solutions

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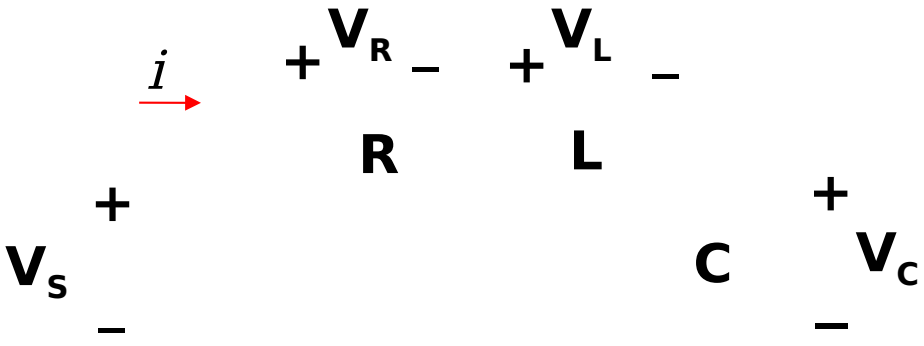
ne state model follows as:

Q2

der the RLC Any system can be modeled by the following eq

The system variables are



RLC circuit

With

Hence

Solutions

sing state variables as

The state equation follows as:

he equation for the output

Solutions

Hence

The state equations can be written in a vector matrix form

and

Solution Using Laplace Transform

he state equations:

ng the Laplace transform for the first equation:

Solution Using Laplace Transform

Continuing with the output equation:

ng the Laplace transform for the output equation:

Solution Using Laplace Transform

The transfer function follows as

Solution Using Laplace Transform

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Assuming that a state model is given by

Solution Using Laplace Transform

We have

Solution Using Laplace Transform

The transfer function is